THE TELEGRAPHIC JOURNAL.
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THE CARBON TELEPHONE AND MICROPHONE.

As soon as the details of the microphone of Professor Hughes were published to the world, it was seen by those who were familiar with Edison's Carbon Telephone, that the two inventions were closely allied; and we are hardly surprised to learn that Mr. Edison has set up a claim for priority of invention of the microphone. Following a practice of his country, one of those admirable institutions we are sometimes called upon to admire, but which we are happy to say is not yet introduced amongst us, he has rushed into the public press and made his complaint there. Starting with the assumption that the microphone is essentially identical with the carbon telephone, his case is that Mr. W. H. Preece has committed a breach of confidence, inasmuch as Mr. Edison, at the desire of Mr. Preece, has kept the latter *au courant* with his inventions and experiments, including the carbon telephone, ever since they met in America last year. The Washington *Star*, of April 19, containing an account of his carbon telephone and thermo-pile, was sent by Mr. Edison to Mr. Preece, together with letters from time to time, and Mr. Edison has concluded that Mr. Preece betrayed his confidence to Professor Hughes. "I regard the conduct of Mr. Preece in this matter," says Edison in the *New York Tribune*, of June 8, "as not merely a violation of my rights as an inventor, but as a gross infringement of the confidence obtained under the guise of friendship." Telegrams to a similar effect have also been sent by Edison to Sir William Thomson, and to Mr. Preece himself, calling upon him to set the matter right with details. We deplore the hastiness with which these communications have been made public by Mr. Edison, and take slight exception to the language in which they are couched. It is otherwise, however, with some remarks in the *New York Herald*, of June 4, headed "Brain Stealing:—A most regrettable attempt to steal from Mr. Edison the honour of having invented the thermo-pile is being made in England, where, owing to the inventor's too free explanation of his plan, a knowledge of his secret was obtained. The fact that Mr. Edison trusted to the honour of a party who came out to investigate his inventions, and to whom he confided the particulars of this one, has enabled one of those scientists who could have shewn Columbus how to stand an egg on end after he had seen the great Captain do it, to come before the world claiming an invention on which Edison had been working successfully for a year or more." This quotation, although distinguished by that elegant taste and scrupulous devotion to truth so characteristic of American journalism, is, we trust, no more than the playful flight of a penny-a-liner.

Now, it appears to us, after a study of the subject in dispute, as it appeared at first, that Edison's assumption of the identity of the microphone discovery with his, is erroneous, and we shall presently give our reasons. But, even if they were the same, that fact is not sufficient ground for charging Mr. Preece with breach of confidence. Edison's English telephone patent, and many articles in American and other journals, have made his carbon telephone familiar to scientists, and especially electricians, in England and elsewhere, for nearly a year past. It appears to us almost preposterous to suppose that Professor Hughes required to learn from Mr. Preece about the carbon telephone—an instrument which has been familiar to all English electricians, worthy of the name, for at least nine months, and which was brought before the British Association by Mr. Preece himself in August, 1877. Professor Hughes has told us and shown us by his experiments, that the carbon telephone did not even suggest the microphone; but, even if it had been so, we fail to see that Mr. Edison would thereby be justified in charging Mr. Preece as he has done. It is no secret that Professor Hughes, after making the first articulating microphone, went on in a truly scientific manner, maturing the subject for three months more, ere he communicated his results to anyone at all. The fact that no patent has been taken out, and no gain desired, is an argument in itself against the charge.

It is an error of the American Press to take it for granted that Edison's Telephone suggested the microphone. Professor Hughes has shown in the clearest manner that it was Sir William Thomson's discovery that extension and compression of iron wires altered their electric resistance. This being so, it occurred to Hughes that it might be possible to make the wire itself of a telephone circuit transmit vocal wave currents, by causing the sonorous vibrations of speech to extend and compress it. He therefore tried a piece of wire in a telephone circuit, by plucking it, but with no result, until the wire was strained to the point of breaking, when a grating noise was heard in the telephone, followed by a loud tick, when it broke. This led him to the conclusion, which is the pith of the distinction, between the microphone and carbon telephone. Finding the wire sonorous when in a condition of rupture, he put the broken ends together again under a slight pressure, and, to his joy, discovered that the imperfect joint so obtained could transmit sound, and

was, in fact, a rude microphone. The discovery became clearer on further experiment. It was found to lie in a peculiar property of the mechanical contact of two conductors, which rendered them proportionately sensitive to sonorous or other molecular vibrations. The merit of Professor Hughes' discovery mainly consists in this—that it is a property of the *contact* of two conductors, and that it is not confined to any one, but to all conductors. Edison's claim has been until now, and can only be stated as follows :—"I discovered about two years ago that carbon of various forms, such as plumbago, graphite, gas retort, carbon and lampblack, when moulded in buttons, decreased the resistance to the passage of the electrical current by pressure," (we give his own words). This was an important discovery, but it had been anticipated by M. Clerac, of the French Telegraphic Administration, Paris, who as long ago as 1866, constructed tubes containing powdered carbon, the electric resistance of which, could be regulated by increasing or diminishing the pressure upon it by means of an adjusting screw. Mr. Edison applied it to his carbon telephone in a manner well-known. Now it appears to us, from all accounts, that Mr. Edison, though very nearly discovering the full significance of the microphone, did not do so. He explained the real nature of the property which he had found to exist in carbon and, let us say, the vague but all-comprehensive patent-phrase, "finely divided metals" to be a diminution of resistance in the *mass* of the material. The discovery of the microphone limits it to an effect of the *surfaces of contact*; but it is plain that Edison did not find this out, else we have no hesitation in saying so great an inventor would not have confined himself to buttons of carbon placed between platinum discs. Thus it is that Professor Hughes' discovery explains the true action of Edison's telephone, which is indeed a form, but a disguised form, of the microphone. It may enable the former to rid itself of its mask, and in addition it opens up a wide field of investigation in which other inventions and discoveries now lie hid.

We have not dwelt at length on the power of the microphone for interpreting otherwise inaudible sounds; but that power is sufficiently remarkable to give further evidence that Mr. Edison did not discover the microphone. As for the thermo-pile, we have seen it incidentally mentioned by Professor Hughes that the microphone is extremely sensitive to heat; but we have not understood him to claim the invention of a thermo-pile founded upon this property. We are aware that inventors have carefully to guard the productions of their genius from the piracy of others; but the history of invention indicates that an over-sensitiveness on this point is too common amongst them. The inventor, like the man of science, should content himself with labouring by the method of Faraday, "work, finish, publish," leaving it to the world to judge his achievements. We therefore regret to see an inventor, fast becoming illustrious, rashly posing himself in the newspapers; but we hope that his doing so is rather the fault of his advisers, and of the custom of his country, than of himself.

The following messages have been sent to New York :—

"Sir,—Pray give the most absolute and unqualified denial to the statements made by Edison respecting me. Hughes has not brought out any thermo-pile. His microphone is quite a different instrument to Edison's telephone. It was worked out without any communication with me, or information imparted by me in any way whatever. I knew nothing of it until it was shown to me, together with Prof. Huxley and Mr. Norman Lockyer. I am in no way whatever a coadjutor of Hughes.

W. H. PREECE."

"I emphatically endorse every word of the above message.

D. E. HUGHES."

We have also received the following letter from Professor Hughes :—

To the Editor of the TELEGRAPHIC JOURNAL.

DEAR SIR,—I notice with regret that Mr. Edison has been trying to make the American public believe that he also invented the microphone, and that, simply because in his carbon telephone he made use of a button of carbon, the varying pressure of a diaphragm upon which produces a varying current of electricity! In all his attempts, as far as I can learn, he has never varied from this idea; he has made thin and thick diaphragms, tried many kinds of carbon, &c., but in all, the principle remains the same. The use of carbon, as a varying resistance with varying pressure, is not original with Mr. Edison. Mr. Clerac, Electrician of the French Telegraph Department, supplied me with resistance tubes founded upon this principle in 1866, viz., a glass tube containing powdered carbon, the resistance of which was regulated by the varying pressure of a regulating screw pressing on the carbon. Mr. Edison claims this resistance tube as an original invention or discovery in 1873, or seven years after it was known in Europe; and he will find in the *Journal Telegraphique*, Berne, 1873, that the invention was claimed by a German, but on Mr. Clerac's proving his priority, 1866, it was freely accorded him. So much for the resistance carbon tubes of Mr. Edison, and the principle of which he acknowledges he has adopted in his carbon telephone. As a coincidence, it is curious that the date, 1873, of Mr. Edison's claim to these resistance tubes should be the same when the invention of 1866 was again brought prominently into notice by the remarks in the *Journal Telegraphique*.

I am willing to believe Mr. Edison was ignorant of these facts until the present time, but he ought now to investigate them, and give credit where it is due.

The microphone which, with the numerous forms now in use, after many months of inces-

sant labour and study I discovered and invented, is entirely different in principle, action, form, uses, and results to the carbon transmitter of Edison, or to Professor Bell's telephone. There is no diaphragm thick or thin, there is no mechanical apparatus by which the sounds are directed or concentrated upon the electrical conducting material; no arrangement to obtain a varying pressure, as we need really a constant one; there is not the slightest necessity for the use of carbon at the contact points, as all metals which do not oxydise act equally well. The sonorous vibrations are taken up by a piece of pine board, or other resonant material, and if on any part of this board, no matter how distant from the speaker or source of sound, two electrical conductors are placed under a very slight but constant pressure; these conductors vibrate exactly as the molecular agitation or vibration of the board and of themselves. Without any regulation, without any change of pressure, a constant electric current is transformed into waves exactly similar in form with the sonorous vibrations. The effect is wonderful, so much so, that the highest scientific intellects of Europe have been struck with surprise and astonishment that such unheard of effects could be produced from an apparatus and causes so apparently simple.

In some of the forms of microphones, I use carbon at the contact points; and, if I believed, for a single instant, that Mr. Edison was the first to use carbon for electrical purposes or for contact points, I would use platina or gold points, which are equal, if not superior, though not so cheap; but, as carbon has long been used in electrical batteries, electric light, resistance tubes, and relay contacts, by myself, I see no necessity to abandon its use simply because Mr. Edison happens to use it in his carbon telephone, in a totally different way, and for different reasons from its use as contact points in the microphone.

An assistant of Mr. Edison, Mr. Adams, presented to the Post Office Telegraphs, about eight weeks since, the latest form of Edison's Carbon Telephone, and, as it was publicly exhibited, I saw it in company with many others. It consisted of an Edison transmitter, and an exact copy of Professor Bell's receiver, which he called an Edison receiver.

The transmitter consisted of a diaphragm (of the same form and materials as Professor Bell's) pressing upon a button of carbon, the varying pressure of the diaphragm upon the carbon producing a varying current of electricity. It was complicated, required not only the use of batteries, but induction coils, and the results were inferior to those of Professor Bell's, against which it was tried in my presence. The Edison receiver was identically the same as Professor Bell's, the only difference being that the natural magnet was brought round so as to touch the diaphragm, in fact, it was so transparent a device to infringe Bell's patent, that the Bell Company at once said they would not permit its use.

If Mr. Edison thinks there are points of resemblance between his carbon transmitter and Professor Bell's Telephone, and anything I have done, it is quite a proper subject for discussion in the scientific journals, but quite unsuitable (being one of a technical nature) for discussion in public journals of general interest; and the technical part of the question must henceforth be discussed by those who, in full possession of the facts, are capable of judging.

But Mr. Edison has made, publicly, a gross personal attack upon the honour of Mr. Preece and myself, and this part he must prove as publicly as he has made it, or stand confessed a wilful slanderer. His message to Sir William Thomson, London, says:—"Edison to Sir W. Thomson. Direct impact carbon telephone sent Preece two months ago, also publications and letters describing its use as heat measurer—great abuse of confidence on his part in Hughes' matter. I send you publications of proofs."

This message seems carefully worded, although it insinuates an abuse of confidence on Mr. Preece's part.

The carbon telephone received through his agent, Mr. Adams, two months since, I have already mentioned, but I had already shown mine some weeks before its arrival at the Post Office, and had tried them in February at the Submarine Telegraph Company, in the presence of its officers. There has been no secret as to the effects of my microphone since last February, but the secret was divulged for the first time in presence of Prof. Huxley, Mr. Norman Lockyer, and Mr. Preece, May 2nd, when it was decided to read a paper upon my discoveries of the last six months, which was done the following week. Mr. Preece could see no resemblance, then nor since, between my microphone and Edison's carbon telephone, and consequently had no confidences to make me, even if he had any from Edison, which I do not believe he had; but even supposing he had informed me then that Mr. Edison was also trying to make a microphone, it would not have prevented me from at once presenting to the world the microphone I had discovered, made, and exhibited at the Submarine Telegraph Company many months before. So it was a gratuitous insult to Mr. Preece and myself to insinuate that simply because he sent a carbon transmitter to the Post Office for trial through his own agent, Mr. Adams, that I should have taken hints from such a failure as it proved to be—to improve that which had already been found successful months before. It bore no resemblance to the microphone in its objects and effects. The main object of Edison's telephone appeared to me to be to avoid Prof. Bell's magnetic transmitter by producing the same effects of telephony in a different way. The main object of the microphone is to render sounds audible hitherto inaudible, and thus to allow us to investigate a new field hitherto unexplored. A mere glimpse, or in fact, a long study, of Edison's carbon-transmitter would not have helped the matter in the slightest. Had I been inclined to imitate, it would certainly have thrown me on the wrong track, as it did him.

Mr. Edison, however, has gone still further. He has sent to the French journals, and published in *Figaro*, June 24, and *Correspondance Scientifique*, June 25, the following, which he declares that he sent to Sir William Thomson.

Edison to Sir William Thomson:—"J'ai envoyé des microphones à MM. Preece et Hughes, il y à deux mois et aussi des déscriptions de cet appareil, il y à abus de confiance de la part de M. Hughes dans cette affaire, attendez mes preuves. —Menlo Park, Juin, 1878.—EDISON."

[TRANSLATION.]

Edison to Sir William Thompson:—"I have sent some microphones to Messrs. Preece and Hughes

two months since, and also some descriptions of that instrument. There is an abuse of confidence on the part of Mr. Hughes in that affair. Await my proofs.—EDISON."

This will be seen to be very differently worded to the one really sent Sir William Thomson, and states directly that he sent me microphones, and that I abused his confidence.

In answer I have only to say that I have never received any microphones, any carbon telephones, any instrument, any description, letter, or communication from him, direct, or indirect, at any time whatever. This I state emphatically, and now call on Mr. Edison to prove the truth of his message I have just quoted from the French journals, and that no further technical discussion can take place until he furnishes such proof.

If he fails in proving the truth of the above message, as he surely will, his conduct will merit the contempt it will receive. D. E. HUGHES.

London, June 27th, 1878.

THE TELEPHONE.

By M. DU BOIS-RAYMOND.

THE telephone has for the physiology of language an importance which has not as yet been sufficiently taken into consideration; also the true explanation of the manner in which it works has not been yet published.

It is this explanation which we will now give as simply as possible, the construction of the telephone of Graham Bell being supposed to be understood.

According to M. Helmholtz, we distinguish a particular quality in a sound, because this sound results from elementary wave vibrations of which the respective periods and the amplitudes are different and determined. And it is not necessary to consider the position which the different waves occupy on the axis of the abscissæ, or the form which the resultant curve necessarily has. This theory has its origin in the theory of the specific energies of nerves under the form which M. Helmholtz has given it, according to which a single nerve-cord only allows of the distinction of differences of quantity in the impressions.

Since certain auditory nerve cords are excited by certain respective intensities, we can distinguish a particular quality, whatever may be the phases of the waves corresponding to the vibrations of the extremities of these cords, which coincide in time, or as we say, whatever may be the differences of the phases of these waves.

In order to understand how, in listening to telephone B, we hear what is said in telephone A, it is sufficient to suppose that an elementary wave vibration of the sound which agitates the air in A, communicates itself to the air which surrounds B, under the form of an elementary wave vibration of a proportional amplitude and of the same duration.

The fact that, under the influence of the wave vibrations of the surrounding air, the iron membrane of A executes similar vibrations, does not require explanation. The smallness of the movements of the membrane allows them to be regarded as sensibly proportional to the variations which take place in the magnetic potential of the membrane, and of the magnet within the bobbin. Thus, for a particular wave vibration of the membrane, this potential varies with the time, and is proportional to a wave which has equal duration, and which, with respect to the other waves of similar sound, has the same relative amplitude as the particular vibration of the membrane and of the air surrounding it.

Let P be this potential, then

$$P = \text{const. } \sin t.$$

The variations of P induce in the coil currents whose electro-motive force is at each moment proportional to $\frac{dP}{dt}$. But we have $\frac{dP}{dt} = \text{const. } \cos t$, from which it follows that the wave movement of the air in front of the membrane produces in the conducting wave of the telephone a current which, in lessening the induction of the wave on itself, is represented in the time by a depression, that is to say by a wave displaced by $\frac{\pi}{2}$ over the axis of the abscissæ. This current produces in its turn a variation of the power of the magnet in B, a variation which, from known observations, is proportional to the power of the current which produces it. It produces in its turn in the membrane B and the air surrounding, movements which are still proportional to it, considering their smallness.

Thus all the elementary wave vibrations which constitute a given sound, transmit themselves from one membrane to the other with their durations and their amplitudes relative, because from the fundamental principle of electric induction, wave vibrations in space produce depressions of the current in the time. But it should be remarked that, in consequence of this transformation, the phases of the different waves which coincide at the moment of excitation of the induction current, are completely turned over, each wave being displaced for a quarter of its length, so that the form of the resultant curve for the air which limits B, becomes altogether different from that which represents the movement of the air in A.

The possibility of a correspondence by the telephone thus rests upon two circumstances:—firstly, the particular form which connects the force of induction with the variation in potential; secondly, the fact that the quality is independent of the difference of the phases of the waves which compose the sound.

In his celebrated researches on vocal synthesis, M. Helmholtz has shown this independence in a rather complicated manner, either by tuning forks put out of tune in order to obtain differences of phases, or by reversing the current in the electro-magnet of his tuning forks.

A simple and efficient means of showing this fact at a lecture, consists in setting in vibration with a bow two tuning-forks of König, giving ut_3 and ut_4, and sharply silencing the second. The quality of the tone then passes suddenly from $\overset{\circ}{a}$ to *ou*, and that in a manner strikingly independent of the difference of the phase which, in this manner of operating, cannot happen twice the same. But it is impossible after all, to have a more striking proof in favour of the theory of M. Helmholtz than the fact of the possibility of the transmission of quality by the telephone.

Although we have up to the present only spoken of musical sounds, which alone are formed of regular waves, what we have said still applies with sufficient exactitude to the irregular vibrations of noise.

The theory of the telephone does not then involve any new principle, and the phenomena do not present anything beyond what was already known. The existing theories would, therefore, have been sufficient to have led to the invention of the telephone some time ago. But that which anyone cannot forsee, and that which always astonishes, even now that the telephone exists, is the rapidity with which these actions are propagated. This remarkable example of a double transformation of forces producing a final loss of mechanical energy also small, still shows at once what many facts have already indicated: that is, that in the propagation of molecular actions, there is less force transformed into heat than is the case when the transmission from one mass to another is accompanied by movements.

Under these circumstances, it appears that we must take pains to study otherwise than by audition, the electric currents in the wire of the telephone. As it acts by alternate currents, their actions on the magnetic needle would be inappreciable; but the electro-dynamometer of Weber would be able to show these currents, and enable their power from different sounds to be studied.

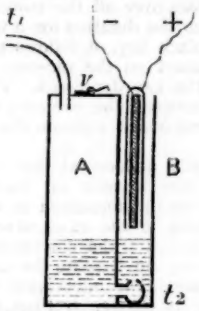
There is still a method of studying these currents. As M. Grassmann has shown, the currents induced by musical vibrations from a magnetized bar affect a frog's leg galvanoscope. It is easy, then, to obtain the same results from telephonic currents. It is sufficient, in the place of attaching the two extremities of the wire to the terminals of B, to put them in communication with those of the moistened exciting tube, on the electrodes of which the nerve rests; then the leg shows the shocks immediately anyone speaks, sings, or whistles in telephone A, or even if the mouthpiece of latter is placed a little roughly on the table. It can be seen at the same time that the nerve is more sensitive to certain sounds than to others. If anyone cries *zücke* (contract) to the instrument, the leg of the frog commences to move; on the first *i* of *liege still* (keep still) it does not move. The sounds which have characteristic harmonic basses act more vigorously than those which are higher; so, in the experiments of M. Grassmann, the bar vibrating transversely about its middle, acts more strongly than when it vibrates in nodes.—*Archives des Sciences Physiques de Geneve.*

A PORTABLE BYRNE'S PNEUMATIC BATTERY.

By H. R. KEMPE.

THE inconvenience in this battery, of having to lift the plates out of the exciting solution when the battery is not required for use, is well known; and no attempt, so far as I know, has been made to get rid of it. The following arrangement has suggested itself to me as a good method of remedying the inconvenience:—

Each battery cell is divided into two chambers, A and B; the former is closed in air-tight at the top, the latter is open, and contains the battery plates, to which the leading wires — and + are attached. The plates do not reach to the bottom of the cell, but to a distance proportionate to the relative sizes of the chambers A and B: thus, if A and B are made equal, the plates would reach only half-way down; if A is twice as large as B, the plates would then reach two-thirds down. t_1 is the air-tube through which the air from the bellows is blown when the battery is to be put in action; t_2 is the ordinary perforated tube in the usual form of the battery; this tube is connected to the chamber A, as shown in the fig. The solution is poured into the cells so as to fill them nearly to the height of the plates, a valve, *v*, being kept open so as to allow the level of the liquids in the two chambers to be normally equal.



The action of the apparatus is almost obvious: on blowing through tube t, the air forces out the liquid from A, through t_2, into B, and fills the latter; when all the liquid is drawn out of A, the air continually supplied through t_1 bubbles up through t_2, and excites the battery in the ordinary manner.

When the use of the battery is to be discontinued, the valve, *v*, is opened for an instant, and the liquid again retreats into A, and uncovers the plates.

ELECTRIC TELEGRAPHY AT THE UNIVERSAL EXHIBITION OF 1878.

By LE COMTE DU MONCEL.

(*Continued from page* 248.)

LIKE that of M. Baudot, to which it gave rise, this system is based upon the successive transmission of signals made by several *employés* at the same instant, and which a distributor mechanically sends through the line one after another, but in such a manner that each one is received only by the proper receiver. To this end the two distributors at the two stations travel synchronously and establish between the manipulators and receivers, which should travel together, momentary electric connections which permit the combinations for each of the signals to be reproduced.

The signals sent in this system are those of the Morse alphabet, and the elementary ones intended to produce them must be made simultaneously in order that the entire signal, that is the letter, may be presented to the transmitting apparatus quite prepared. For this purpose each manipulator is composed of eight keys, arranged like those of a piano, the whites corresponding to the dashes and the blacks to the dots of the Morse alphabet; and each section of the distributor worked by one *employé* is furnished with eight contacts, alternating with four non-contact pieces, and spread over a more or less extended arc, on a circular disc of

ebonite which constitutes the distributor and carries the contact of all the sections. If the apparatus is intended for six transmissions, this disc carries forty-eight contacts, or sixty-four if for eight transmissions. These contacts are grouped in pairs, and are joined by wires to the keys of the corresponding manipulator, so that when a white key is depressed the battery is put in simultaneous communication with two contiguous contacts; when a black key is depressed the battery communicates with only one contact. Thus as the contact-maker of the distributor which passes over all the contacts transmits currents of twice the duration for a white key that it does for a black key, it follows that dots and dashes are obtained on the receiver, according to the nature of the key depressed. The insulating spaces placed between the contacts naturally correspond to spaces which separate the signals, dots or dashes.

It is now easily understood that on depressing simultaneously the number of black and white keys, necessary for the formation of a letter (starting from the left), at the exact moment that the contact maker arrives at the corresponding portion of the distributor, and keeping the keys depressed for a few moments, the interruptor will produce successively, by its passage over the different contacts, the number of long and short currents necessary for the formation of the letter on the corresponding receiver, so that the impression of this letter takes place in consequence of a manipulation made at one stroke.

The receiver, corresponding to each manipulator, is somewhat similar in arrangement to the Morse receiver, but the tracer, instead of being a disc (or rowel), is a cylinder, furnished with a projecting lever in form of a helix, but presenting for each apparatus only a fraction of a complete helix, which fraction may be one-fourth, one-sixth, or one-eighth, according to the number of transmissions intended to be accomplished; and the position of this portion of the helix on the cylinders is such that each one is the sequel to the preceding one, so that all these spiral portions, if brought together, would make up one complete spiral.

The helix of the receivers, and the contact maker of the distributor, perform their revolutions in the same time, the latter passing over the first section of the distributor while the first spiral progresses in front of the strip of paper which passes underneath and which is to receive the message; and so with the others. An inking-pad turns freely on each of the helices; and underneath the paper band is placed a sharp-edged lever-frame, which when actuated by an electro-magnet carries the paper to the inked helix at the moments of closing of the circuit, producing impressions, of which each portion is relative to the point of the projecting helix at that moment before the paper; so that these impressions may be long or short accordingly as they are isolated or juxtaposed. As the position of the different points of the projecting helix answers exactly to that of the contacts of each section of the distributor, the marks produced are an exact reproduction of the signals sent.

In the Meyer receivers the axis of the projecting helix is perpendicular to the length of the paper band, so that all the elementary signals composing one letter are produced transversely with regard to the paper, and appear one under the other. In reading, therefore, it is necessary to pass the eye vertically up the band as it travels before one.

It will be understood, however, that to obtain a regular action with these instruments, the essential condition is a perfect synchronism between the corresponding distributors and the receivers connected with them. As the receivers are in mechanical relation as to motion with the distributor, their synchronism can be easily effected; but it is not so with the distributors, and M. Meyer has had to devise a special system, which has succeeded perfectly and which does the greatest honour to the inventive genius of its author, and also to the ability of M. Hardy, the constructor of the apparatus. It would be difficult to explain this ingenious device without figures, but its description is in no way necessary to a comprehension of M. Meyer's system.

APPARATUS FOR INDICATING THE OUTBREAK OF FIRE IN SHIPS' CARGOES.

By F. HIGGINS.

THIS apparatus, which is patented, consists of an indicator for the captain's cabin connected by wires to thermostats placed on the beams or stanchions of vessels, or in such other positions as may be necessitated by the nature of the cargo.

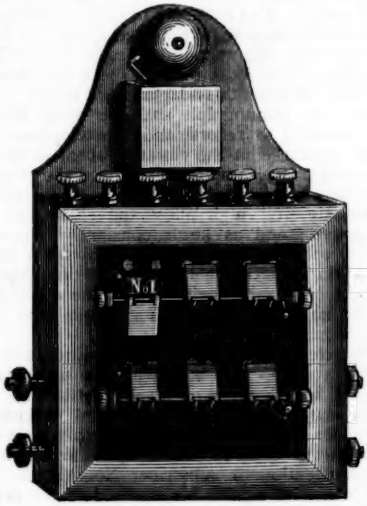
This system differs from those hitherto suggested for this purpose, in the manner of giving the alarm and in the connections. A current from a battery is caused to flow through an electrical circuit composed of an electro-magnet and one or more thermostats. As long as the circuit is complete, a kind of shutter on the indicator dial is upheld by the electro-magnet, but upon an increase of temperature taking place the circuit is opened by the thermostats, the shutter is released, and falls by gravitation, thus exposing to view the number of the section of the ship in which the thermostats are placed, and at the same time causing a trembler bell to ring. This ringing continues until stopped by hand.

The reason for the employment of a normally closed circuit, the continuity of which is intended to be ruptured by any abnormal temperatue, is, that circuits normally open give no indication of a breakage of the conductor, and may fail to announce a rise of temperature from many other causes. Such arrangements also require to be tested constantly, and from the fact of the most important part of the system being inaccessible, there would be a chance of the apparatus failing to perform its duty.

This element of unreliability is eliminated from the present apparatus, and any accident to the conductor or battery would announce itself immediately upon its occurrence, and thus afford an opportunity for repair, or, if that should not be possible at sea, it would simply leave the damaged section negatively protected; for in case of an outbreak of fire not being announced from protected sections, it would obviously be in the one unprotected.

The chief object of this system is not, however, to announce an actual outbreak, but to give warning of dangerous heating. The thermostats consist

of a compound bar of zinc and steel, or a spiral of brass and steel enclosed in a tube, one end being fixed and the free end resting at ordinary temperatures upon a contact piece. The zinc and steel combination is the most sensitive and performs very well if the zinc be annealed in boiling water and the contact arranged with a spring so as to relieve the zinc from any strain. Without the latter precaution the zinc will give way in course of time, and the bar lose its original adjustment.



A rise of 20° F. will cause the free end of such a bar 4½ in. long to move $\frac{3}{16}$ in. from its contact point, there is, therefore, sufficient movement and force to ensure correct performance.

For a large ship, with 18 thermostats, a battery of two bichromate cells would be employed, and would be of sufficient capacity to furnish the necessary power for six months. Should it become necessary to recharge the batteries at sea, no difficulty would be experienced in doing so. Much more difficult operations are readily undertaken by captains of ships.

The drawing shows the arrangement. The two binding screws at the right side connect the battery with bell, those on the left give connection with the electro-magnets, and the six screws on the upper part of the indicator are for connecting up the thermostats.

THE PHONOGRAPH AND ITS FUTURE.

By T. A. EDISON. *

(*Continued from page* 251.)

THE foregoing presentment of the stage of development reached by the several essential features of the phonograph demonstrates the following as *faits accomplis:*

1. The captivity of all manner of sound waves heretofore designated as "fugitive," and their permanent retention.

2. Their reproduction with all their original characteristics at will without the presence or consent of the original source, and after the lapse of any period of time.

3. The transmission of such captive sounds through the ordinary channels of commercial intercourse and trade in material form, for purposes of communication or as merchantable goods.

4. Indefinite multiplication and preservation of such sounds without regard to the existence or non-existence of the original source.

5. The captivation of sounds, with or without the knowledge or consent of the source of their origin.

The probable applications of these properties of the phonograph and the various branches of commercial and scientific industry presently indicated will require the exercise of more or less mechanical ingenuity. Conceding that the apparatus is practically perfected in so far as the faithful reproduction of sound is concerned, many of the following applications will be made the moment the new form of apparatus, which the writer is now about completing, is finished. These then might be classed as actualities; but they so closely trench upon other applications which will immediately follow, that it is impossible to separate them: hence they are all enumerated under the head of probabilities, and each specially considered. Among the more important may be mentioned letter-writing and other forms of dictation books, education, reader, music, family record, and such electrotype applications as books, musical boxes, toys, clocks, advertising and signalling apparatus, speeches, &c., &c.

Letter-writing.—The apparatus now being perfected in mechanical details will be the standard phonograph, and may be used for all purposes, except such as require special forms of matrix, such as toys, clocks, &c., for an indefinite repetition of the same thing. The main utility of the phonograph, however, being for the purpose of letter-writing and other forms of dictation, the design is made with a view to its utility for that purpose.

"The general principles of construction are a flat plate or disc, with spiral groove on the face, operated by clock-work underneath the plate; the grooves are cut very closely together, so as to give a great total length to each inch of surface—a close calculation gives as the capacity of each sheet of foil, upon which the record is had, in the neighbourhood of 40,000 words. The sheets being but ten inches square, the cost is so trifling that 100 words might be put upon a single sheet economically.

"The practical application of this form of phonograph for communications is very simple. A sheet of foil is placed in the phonograph, the clock-work set in motion, and the matter dictated into the mouth-piece without other effort than when dictating to a stenographer. It is then removed, placed in a suitable form of envelope, and sent through the ordinary channels to the correspondent for whom designed. He placing it upon his phonograph, starts his clock-work and *listens* to what his correspondent has to say. Inasmuch as it gives the tone of voice of his correspondent, it is *identified.* As it may be filed away as other letters, and at any subsequent time reproduced, it is a perfect *record.* As two sheets of foil have been indented with the same facility as a single sheet, the 'writer' may thus *keep a duplicate* of his communication."

As the principal of a business house, or his

* From *The North American Review*, May-June, 1878.

partners now dictate the important business communication to clerks to be written out, they are required to do no more by the phonographic method, and do thereby *dispense with the clerk*, and *maintain perfect privacy* in their communications.

"The phonograph letters may be dictated at home, or in the office of a friend, the *presence* of a stenographer *not being required*. The dictation may be as rapid as the thoughts can be formed, or the lips utter them. The recipient may listen to his letters being read at a rate of from 150 to 200 words per minute, and at the same time busy himself about other matters. Interjections, explanations, emphasis, exclamations, &c., may be thrown into such letters *ad libitum*."

In the early days of the phonograph, ere it has become universally adopted, a correspondent in Hong Kong may possibly not be supplied with an apparatus, thus necessitating a written letter of the old-fashioned sort. In that case the writer would use his phonograph simply as a dictating machine, his clerk writing it out from the phonograph at leisure, causing as many words to be uttered at one time as his memory was capable of retaining until he had written them down. This clerk need not be a stenographer, nor need he have been present when the letter was dictated.

"The advantages of such an innovation upon the present slow, tedious, and costly methods are too numerous, and too readily suggest themselves, to warrant their enumeration, while there are no disadvantages which will not disappear coincident with the general introduction of the new method."

Mr. Edison then points out that all kinds of dictation may be readily effected with the delicate phonograph which is in the near future. The utterances of court and parliament will be recorded; and the newspaper printer will read by ear, using his eyes for the type exclusively. Books will be read mechanically to patients or others whose eyes are engaged over work in the style of excellent elocutionists. As a teacher of elocution, pronunciation, and spelling, the phonograph will be useful. It will also teach and perform music, preserve the voices of dead friends and the sounds of dead languages. The *quality* of the voice is the only element which may not be perfectly reproduced. Toy animals and dolls shall give their characteristic sounds. Clocks shall announce the hours *viva voce*, call to lunch, &c., and advertising shall be carried on by phonograph.

"Lastly, and in quite another direction, the phonograph will *perfect the telephone*, and revolutionise present *systems of telegraphy*. That useful invention is now restricted in its field of operation by reason of the fact that it is a means of communication which leaves no record of its transactions, thus restricting its use to simple conversational chit-chat, and such unimportant details of business as are not considered of sufficient importance to record. Were this different, and our telephone conversation automatically recorded, we should find the reverse of the present status of the telephone. It would be expressly resorted to *as* a means of perfect record.

"'How can this application be made?' will probably be asked by those unfamiliar with either the telephone or phonograph.

"Both these inventions cause a plate or disc to vibrate, and thus produce sound-waves in harmony with those of the voice of the speaker. A very simple device may be made by which the one vibrating disc may be made to do duty for both the telephone and the phonograph, thus enabling the speaker to *simultaneously transmit and record his message*. What system of telegraphy can approach that? A similar combination at the distant end of the wire enables the correspondent, if he is present, *to hear it while it is being recorded*. Thus we have a mere passage of words for the action, but a complete and durable record of those words as the result of that action. Can economy of time or money go further than to annihilate time and space, and bottle up for posterity the mere utterance of man, without other effort on his part than to speak the words?"

In order to make this adaptation, it is only requisite that the phonograph shall be made slightly more sensitive to record, and the telephone very slightly increased in the vibrating force of the receiver, and it is accomplished. Indeed, the "Carbon telephone invented and perfected by the writer, will already well nigh affect the record on the phonograph; and as he is constantly improving upon it, to cause a more decided vibration of the plate of the receiver, this addition to the telephone may be looked for coincident with the other practical applications of the phonograph, and with almost equal certainty.

"The telegraph company of the future—and that no distant one—will be simply an organization having a huge system of wires, central and subcentral stations, managed by skilled attendants, whose sole duty it will be to keep wires in proper repair, and give, by switch or shunt arrangement, prompt attention to subscriber No. 923 in New York, when he signals his desire to have private communication with subscriber No. 1001 in Boston, for three minutes. The minor and totally inconsequent details which seems to arise as to obstacles in the eyes of the groove-travelling telegraph man, wedded to existing methods, will wholly disappear before that remorseless Juggernaut—'the needs of man;' for, will not the necessities of man surmount trifles in order to reap the full benefit of an invention which practically brings him face to face with whom he will; and, better still, doing the work of a conscientious and infallible scribe?"

Mr. Edison is certainly very hopeful of the future of the wonderful instrument he has invented, but we think, not too hopeful; for, after the invention itself and its most recent development, the microphone, it would be rash to say that any application of it is impossible. Certainly some substitute or substitutes for the clumsy mode of recording our thoughts by pen and ink, so inconsistent with the general rapidity of our time, must be close at hand; and what form one of these substitutes may take seems pretty clearly pointed out by the actual uses to which Mr. Edison's invention has been put.

EDISON'S THERMO-PILE.

ONE of Mr. Edison's latest inventive effusions is the carbon thermo-pile. It is based on the principle of the carbon telephone, now so well elucidated by the microphone. The sensitive part consists of a cube of prepared carbon or charcoal, confined between

two thin iron plates, and a fine slip of horn or quill, inserted between the second plate, and a third metal plate or clamp. This sensitive arrangement is connected in circuit with a battery, and a galvanometer. When heat-rays are allowed to fall on the slip of horn, it expands lengthwise and presses on the charcoal, reducing the electric resistance of the latter proportionately to the pressure. There is thus a corresponding rush of electricity through the circuit, causing a deflection on the galvanometer. The arrangement is exceedingly sensitive, the heat emanating from the hand being sufficient to give a deflection of 10°, with a single cell, through a galvanometer of about 2000 ohms resistance. It is said that Mr. Edison hopes to measure the heat from the fixed stars with it.

PROFESSOR CLERK-MAXWELL ON THE TELEPHONE.

(*Continued from page 252.*)

ONE great beauty of Professor Bell's invention is that the instruments at the two ends of the line are precisely alike. When the tin plate of the transmitter approaches the core of its bobbin, it produces a current in the circuit, which has also to circulate round the bobbin of the receiver, and thus the core of the receiver is rendered more or less magnetic, and attracts its tin plate with greater or smaller force. Thus the tin plate of the receiver reproduces on a smaller scale, but with perfect fidelity, every motion of the tin plate of the transmitter.

This perfect symmetry of the whole apparatus—the wire in the middle, the two telephones at the end of the wire and the two gossips at the ends of the telephones—may be very fascinating to a mere mathematician, but it would not satisfy an evolutionist of the Spenserian type, who would consider anything with both ends alike to be an organism of a very low type, which must have its functions differentiated before any satisfactory integration can take place.

Accordingly, many attempts have been made by differentiating the function of the transmitter from that of the receiver to overcome the principal limitation to the power of the telephone. As long as the human voice is the sole motive power of the apparatus, it is manifest that what is heard at one end must be fainter than what is spoken at the other. But if the vibration set up by the voice is used no longer as the source of energy, but merely as a means of modulating the strength of a current produced by a voltaic battery, then there will be no necessary limitation of the intensity of the resulting sound, so that what is whispered to the transmitter may be proclaimed *ore rotundo* by the receiver.

A result of this kind has already been obtained by Mr. Edison, by means of a transmitter in which the sound vibrations produce a varying pressure on a piece of carbon, which forms part of the electric circuit. The greater the pressure, the smaller is the resistance due to the insertion of the carbon, and, therefore, the greater is the current in the circuit.

I have said that the telephone is an instance of the benefit to be derived from the cross-fertilization of the sciences. Now, this is an operation which cannot be performed by merely collecting treatises on the different sciences, and binding them up into an encyclopædia. Science exists only in the mind, and the union of the sciences can take place only in a living person.

Now, Professor Graham Bell, the inventor of the telephone, is not an electrician who has found out how to make a tin plate speak, but a speaker who, to gain his private ends, has become an electrician. He is the son of a very remarkable man, Alexander Melville Bell, author of a book called "Visible Speech," and of other works relating to pronunciation; in fact, his whole life has been employed in teaching people to speak. He brought the art to such perfection that, though a Scotchman, he taught himself in six months to speak English. Mr. Melville Bell has made a complete analysis and classification of all the sounds capable of being uttered by the human voice, from the Zulu clicks to coughing and sneezing; and he has embodied his results in a system of symbols, the elements of which are not taken from any existing alphabet, but are founded on the different configurations of the organs of speech.

The inventor of the telephone, who had assisted his father, was thus prepared, by early training in the practical analysis of the elements of speech, to associate whatever scientific knowledge he might afterwards acquire with those elementary sensations and actions, which each of us must learn for himself, because they lie too deep within us to be described to others. This training was put to a very severe test when, at the request of the Boston Board of Education, Professor Graham Bell conducted a series of experiments with his father's system, in the Boston School for the Deaf and Dumb. I cannot conceive a nobler application of the scientific analysis of speech than that by which it enables those to whom all sound is

> "expunged and razed,
> And wisdom at one entrance quite shut out,"

not only to speak themselves, but to read by sight what other people are saying. The successful result of the experiments at Boston is not only the most valuable testimonial to the father's system of visible speech, but an honour which the inventor of the telephone may well consider as the highest he has attained.

Among all the recent steps in the progress of science, I know none of which the truly scientific or science-producing consequences are likely to be so influential as the rise of a school of physiologists, who investigate the conditions of our sensations by producing on the external senses impressions, the physical conditions of which can be measured with precision, and then recording the verdict of consciousness as to the similarity or difference of the resulting sensations.

Professor Helmholtz, in his recent address as rector of the University of Berlin, lays great stress on that personal interaction between living minds, which I have already spoken of as essential to the life of a university.

No man has done more than Helmholtz to open up paths of communication between isolated departments of human knowledge; and one of these, lying in a more attractive region than that of elementary psychology, might be explored under exceptionally favourable conditions, by some of the

fresh minds now coming up to Cambridge. I mean a combined study of music and acoustics. The special educational value of such a study lies in the fact that it, more than almost anything, involves a continual appeal to what we must observe for ourselves.

These facts are things which must be felt: they cannot be learned from any description of them.

All this has been said more than two hundred years ago by one of our own prophets, William Harvey, of Gonville and Caius College:—"For whosoever they be that read authors, and do not, by the aid of their own senses, abstract true representations of the things themselves (comprehended in the author's expressions), they do not represent true ideas, but deceitful idols and phantasms, by which means they frame to themselves certain shadows and chimeras, and all their theory and contemplation (which they call science) represents nothing but waking men's dreams and sick men's phrensies."

Notes.

WE observe with great regret that our contemporary on the other side of the Atlantic has taken in a captious spirit some remarks in an article of ours which was intended to be a tribute of the greatest possible respect to the memory of a man of mark. It is unfortunate that the grace of our desire should have been marred by unasked for and questionable criticism. We do not wish to enter into controversy, but we may say that one fact was one which the person most affected was proud of acknowledging; the other was not only the result of observation, but is vouched for by one most affected, and the third is unfortunately too patent to all the world, principally because it is the daily burden of the American press.

THE TELEPHONE.—The "watch" telephone is the newest form of this instrument. It is the size and form of an old-fashioned turnip watch, and can be easily carried in the pocket. The bar magnet is curled round itself, and the coil is fixed to the central pole.

TELEPHONIC communication is rapidly spreading between the American cities. In some parts the charge is only five cents a message, with an extra five cents if it is required to be delivered outside the office.

IN a recent number of the American *Polytechnic Review*, Professors Elihu Thomson and E. J. Houston describe a telephone of their invention, named the "Reaction telephone." In form it resembles a Bell telephone, the magnet being a soft iron core, and the coil an induction bobbin with the primary wound on one end or pole of the core. The inner face of the diaphragm carries a spike of carbon, whose point makes contact with a globule of mercury, which is let into a cavity in the end of the iron core. A battery is joined up in circuit with the primary coil, the mercury, and carbon probe, while the secondary coil is connected in circuit with the line. When the diaphragm vibrates under the voice, the probe dips to and fro in the mercury and produces undulations in the primary current, setting up wave currents in the secondary coil, which traverse the line and cause a similar telephone to speak. The electro-magnetic action between the pole of the core and the diaphragm as the primary current varies, gives to this telephone its peculiar name.

PROFESSORS ELIHU THOMSON and E. J. HOUSTON, of Central High School, Philadelphia, write to our contemporary, *Nature*, to say that they have finally solved the important problem of *relaying* telephone sounds. They have effected it by the application of a small Hughes' microphone to the diaphragm of the telephone, the microphone being in circuit with the line over which the sound is required to be relayed. This application was pointed out, as we reported in our last number, by Professor Hughes, at the meeting of the Physical Society on June 17th.

THE MICROPHONE.—We understand that Professor Hughes had himself observed the phenomenon first publicly announced by Mr. Blyth, Edinburgh, namely, that the microphone acts as a receiver as well as a transmitter. It appears that Professor Hughes obtained articulation from ordinary microphones before Mr. Blyth obtained it from his cinder-pot, but it was so feeble that he did not publish the fact at once, although he communicated it in a letter to Mr. W. H. Preece. This circumstance should in no way detract from the merit of Mr. Blyth's discovery, and it is probable that the multiplicity of contacts afforded by the mass of cinders increases the power of the sound given out.

PROFESSOR HUGHES states that any microphone will act as a receiver, and give out sounds if properly adjusted. The microphone which is best as a transmitter will also be best as a receiver, that is to say, the state of adjustment, and the material which transmits sounds most loudly and distinctly will also utter them most loudly and distinctly. Thus pine charcoal gives superior results both as a transmitter and receiver.

THE better effect obtained by Mr. Blyth in his experiments with cinders as a microphone (see our last issue, p. 246) on moistening the latter, may be explained on the supposition that the moisture added weight to the cinders, and consequently produced more requisite pressure at the cinder contacts.

THE microphone is a striking illustration of the truth that in science any phenomenon whatever may be turned to account. The trouble of one generation of scientists may be turned to the honour and service of the next. Electricians have long had sore reasons for regarding a "bad contact" as an unmitigated nuisance,

the instrument of the Evil One, with no conceivable good in it, and no conceivable purpose except to annoy and tempt them into wickedness and an expression of hearty but ignominious emotion. Professor Hughes, however, has with a wizard's power, transformed this electrician's bane into a professional glory and a public boon. Verily, there is a soul of virtue in things evil.

THE PHONOGRAPH.—In America the phonograph is neither sold nor leased to private individuals yet, but is let out to agents, who pay a royalty of one-fourth the gross receipts for the use of it.

THE moto-phone is the name given by Mr. Edison to a little mechanical curiosity of his in the shape of a motor driven by the voice. The phonographic vibrations of a diaphragm are caused to rotate an axle by means of a stylus and ratchet wheel.

IT IS remarkable that the phonograph foil may be crumpled up in the hand without destroying the reproductive power of the record.

EDISON has perfected a fog-horn that can be heard ten miles, but when it comes to an invention for getting his hired girl up in the morning, he smiles sadly, and falls to musing on the infinite.—*Utica (U.S.) Observer.*

A LONG-DISTANCE TELEGRAM.—A telegram of thirty-three words was recently sent from Auburn, U.S., to Sydney, Australia, costing 65 dollars. Its course was from Auburn to New York, Heart's Content, Newfoundland, Valencia, London, through Germany, Russia, and Siberia, to Wladiwoodstock, a point on the coast of Manchuria; thence to Nagasaki, Japan; thence through the Yellow Sea to Shanghai, China; thence down the coast of China, by Saigon, Siam, Singapore, and Batavia, to Port Darwin, on the northern coast of Australia; and thence to Sydney, New South Wales.

DURING the afternoon of Sunday, June 23, a thunderstorm of tropical violence raged over London. The lightning was both forked and sheet, the thunder-claps resembled sharp salvoes of artillery, and the rain literally came down in bucketfulls. Many houses, chimneys, and trees were struck by the lightning, and in various parts of the city and suburbs the lower rooms and cellars of streets were flooded by the rain, or the bursting of water-pipes. A sewer gave way at King's Cross, and flooded the Metropolitan Railway line as far as Farringdon Street, so that traffic had to be suspended. At South Hackney the lightning struck the back of a house, breaking the glass, and tearing up the frames of the windows of a room, then passing through the floor to the room beneath. A splinter of wood was flung upon a bed in the apartment where two infants were sleeping, without injuring them. In the Walworth-road district a house in Mann-street was struck, the lower rooms appearing for an instant full of flame; carpets and rugs were set a-fire, the fire-irons twisted and broken, and a lady occupant severely burned on the right hand and arm, her hair being also singed. At Croydon the rain was mingled with large hailstones, some the size of a marble, and in general of a truncated-conical shape. A large elm tree in the neighbourhood was furrowed down its trunk and two main limbs by the track of the discharge, which had burst off the thick outer bark, at places laying bare the wood underneath. The two furrows ran irregularly down the opposite sides of the trunk, and ended at the points where a black tarred paling abutted on the tree, and was nailed to the trunk.

A RUSTIC LIGHTNING ROD.—A French agricultural paper announces the discovery that bundles of straw bound on broom-handles and stuck upright over the roof will effectively protect a house from lightning. The first trials of this apparatus were recently made at Tarbes (Hautes Pyrenées) by some intelligent agriculturists, and the results were so satisfactory that soon afterwards eighteen communes of the Tarbes district decorated their houses with these "stuck-up" but at the same time unostentatious and ingenuous lightning protectors, and it is reported that there have been no accidents from lightning since. By what experimental process the intelligent agriculturists came to their conclusion is not stated; nor can we learn what the idea was which inspired the plan, although it appears to have been the old proverb about a hair of the dog which bit you, for it has long been known that witches ride the storm on broomsticks.

WE learn from the *Operator*, U.S., that it is proposed to form a protective association amongst American telegraphists. The monopoly of the Western Union Company, and the recent unpopular measures of salary gradation in that company, have helped to render such a step prudent on the part of operators. No strike or aggressive policy is at present contemplated, the organization being regarded as a safeguard for the future.

THERE are now 125 telegraph stations in Japan, and over 5,000 miles of wire. More than 1,000 miles of line are in course of construction, and the system will be still further extended. The first practical telegraphic line in Japan was put up at the close of the year 1869, and the advance made since then is highly creditable to Japanese enterprise.

AT the great *fête* to be given by the City of Paris, several of the most popular parts of the city will be illuminated during the whole night by splendid lustres of Jablochkoff electric candles. It is estimated that there will be as many as 200 candles lit.

A CABLE is now being laid between Constantinople and Salonica.

WE are gratified to learn that some £50 have been subscribed for placing a stone over the grave of Alexander Bain. The stone and inscription will be a simple one; but it is right that some such memorial should mark the spot where the great but ill-starred inventor lies. His fame requires no monument. In the French Telegraphic annexe at the Paris Exhibition, there is a kind of electrical trophy in the centre of the hall, inscribed with the names of a few of the most famous electricians; one of the names is "Bain."

THE Singapore Hongkong Cable of the Great Northern Company having been restored, the repairs of this Company's Hongkong Amoy Cable will now be continued. Until the repairs are effected, the Company cannot accept Messages for Hongkong; but meanwhile the Company's lines are the only telegraph route to Amoy (Foochow), Shanghai, and the stations in Japan.

CABLE REPAIRING IN THE WEST INDIES.—The steamship *Professor Morse*, belonging to the International Ocean Telegraphic Company, in command of Captain Thos. Stead, sailed from New York, Thursday May 30th, for Key West, to repair the Company's No. 2 Cable (south) which was reported broken some weeks since, about 27½ miles from Sand Key Light. The expedition is in charge of Mr. George Keith, Manager of the Cuba Submarine Company's Cables at Cienfuegos, who has had considerable experience in grappling for and laying cables in deep water. He will be assisted by the Company's superintendent of cables, Mr. M. L. Nellings, stationed at Key West. Mr. G. B. Prescott, Director of the electrician's office, accompanies the expedition, also Mr. James Orton. It is expected the *Morse* will be absent about a month. —*Journal of the Telegraph*, U.S.

The Virginia, U.S., telegraph line, including the branch from Alexandria to Pursellville, London County, has been purchased by the Western Union Telegraph Company.

MR. TEGG, the well-known publisher, is writing a work on "Posts and Telegraphs, Past and Present," to which will be appended an account of the telephone and phonograph.

A BIOGRAPHY of the late Mr. Alfred Smee, F.R.S., with selections from his writings on scientific and social subjects, is in the press. It is edited by his daughter, Mrs. Odling.

M. EDMOND BECQUEREL has been elected Professor of Applied Physics and Natural History in the room of his late father.

ON July 1st, a publication, entitled *L'electricite*, will appear, for the purpose of promoting the holding of a special electrical exhibition in the Palais de l'Industrie, Paris, in 1879.

DR. ALEXANDER MUIRHEAD, who has recently returned from America, after duplexing the Direct United States Cable, is, we believe, about to start for Madras to duplex the Madras-Penang Cable. Muirhead's duplex system will also be applied shortly to the Malta-Gibraltar cable.

JABLOCHKOFF'S electric candle is rapidly making headway in Paris. Besides the 8 lamps of the Place de l'Opera, and those of the Magasins du Louvre, there are now 24 extending down the fine new Avenue de l'Opera with splendid effect. The place du Théâtre Français, the Palais Bourbon, fronting the Place de la Concorde, the Belle Jardiniere, the Concert de l'Orangerie in the Gardens of the Tuileries, the Arc de Triomphe, and the great Hippodrome at the foot of the Avenue Josephine, are also illuminated by the candle. A powerful lamp is being set up on the pinnacle of the Trocadero Palace.

AN ELECTRICAL GYROSCOPE.—In a recent number of the *Scientific American*, Mr. Geo. M. Hopkins describes an ingenious gyroscope, constructed to rotate continuously by means of electricity. The gyroscope is supported on an upright standard, on which its axis is pivoted horizontally. A double poled electro-magnet is fixed to the back of the gyroscope in such a way as to submit an armature fixed diametrically across the rotating wheel to its attraction, and a contact is arranged so as to break circuit twice every revolution immediately the armature comes opposite the poles of the electro-magnet. In this way the wheel attached to the armature is kept rotating. The wheel, with armature, magnets, and axle, in short the whole gyroscope, is free to be moved in any direction round the point of the upright standard. Two large, or four small, Bunsen cells are sufficient to cause the wheel to revolve with greater velocity, and to make the gyroscope support itself horizontally from the standard in opposition to gravity.

NICKEL PLATING.—M. Kayser in the *Chem. Centr.*, No. 127, 1878, gives the following select conditions for nickel plating. The articles to be plated to be carefully cleaned, and put in a bath composed of one part of the double sulphate of nickel and ammonium to twenty parts of water; the nickel salt to be pure, and also the nickel anode, which should not be smaller than the article to be plated: the current employed to be strong. When the bath gets acid it should be neutralised by the addition of dilute ammonia. In plating copper articles, the bath should contain ammonium chloride, one part to one hundred parts of nickel salt.

ACTION OF LIGHT ON SELENIUM.—M. Forssman, from investigations on the influence of variously coloured lights on selenium, has come to the conclusion that it is not the light vibrations which reduce the

electric resistance of selenium, but vibrations of another order, hitherto unknown, and which have neither a lighting, heating, or chemical effect.

ELECTROLYSIS OF WATER.—M. Bonnet finds that the decomposition of water by the electric current is independent of pressure. His experiments have given results at 154 atmospheres.

INTENSITY OF VOLTAIC POLARISATION.—According to Dr. Fr. Exner the electro-motive force of polarisation produced by currents too feeble to effect a permanent decomposition of water, is constantly and exactly equal to that of the primary current employed.

AT the meeting of the Physical Society reported in the present number, Professor Thomson exhibited by the electric light some beautiful and interesting magnetic figures, illustrating the "lines of force" in electro-dynamic relations. The lines were shown by iron filings fixed, as they had arranged themselves, on panes of glass, by means of powdered gum moistened with steam. They were therefore not only beautiful, those of a wire in which a current is flowing resembling ferns, but they were rigidly faithful. The use of diagrams on glass, so common in America, is happily extending here.

ELECTROLYSIS OF CHEMICAL COMPOUNDS.—M. Bleekrode, by help of De la Rue's chloride of silver battery, has recently tested Hittorf's hypothesis that the resistance of a compound to electrolysis depends on the difficulty with which the molecules exchange their constituents, and the results of his investigation in no way support it. He also endeavoured to ascertain whether in a compound the presence of hydrogen, which can be replaced by metals or radicles, is connected with the capacity of the compound for being electrolysed. The substances examined were all in the liquid state, being condensed by pressure when necessary, and not in solution. They were contained in narrow glass tubes, and decomposed by means of platinum electrodes a few millimetres apart. According to Hittorf, those compounds possessing very active chemical properties, or which easily yield hydrogen, should be easily electrolysed. But water, alcohol, the liquid hydrogen acids, with one exception, are difficult to break up by electrolysis. It should be mentioned, however, that these acids in the pure liquid state are not very active in their chemical properties. The anhydrides of the metals, on the other hand, are both chemically active and conduct electrolytically. The amides, amines, and hydrocarbons showed no correspondence between their chemical properties and conductivity. Nothing definite could be ascertained as to the function of hydrogen, although all the substances either contained hydrogen or a metal. These experiments show ammonia and hydrocyanic acid to be good electrolytic conductors at ordinary temperatures, the only known cases of pure liquids acting in this manner.

ILLUSTRATION OF TERRESTRIAL CURRENTS.—Professor W. Leroy Broun, in *Silliman's American Journal*, gives the following lecture illustration of terrestrial electric currents:—A rectangular frame was made of light poplar laths, in section 3 by 2 centimetres. The length of the frame was a fraction over a metre, its width $\frac{2}{3}$ of a metre. About the perimeter of this frame were wrapped twenty coils of insulated copper wire; each extremity of the wire was made to terminate near the centre of one of the shorter sides, and passing through the wooden frame was fastened and cut off about 3 centimetres from the frame. This rectangular frame was then so suspended, in a horizontal position, by wires attached to the frame of an ordinary hydrostatic balance, that the longer sides were at right angles with the beam. By adjusting weights in the pans the index of the balance was brought to the zero point. Two small orifices bored in a block of wood, a centimetre apart, served as mercury cups, in which the extremities of the short terminal wires were immersed. Near the bottom and through the walls of these wooden cups were screwed small brass hooks, which served as connections, to which the wires of the battery were attached. The balance was now so placed that the longer sides of the suspended rectangle were at *right angles with the magnetic meridian*, or in the *magnetic* east-and-west line.

When the current from the battery was made to pass around the rectangle from east to west on the northern side, and from west to east on the southern side, by the theory of terrestrial magnetism the northern side of the rectangle would be attracted, and the southern repelled; and that this was so, the corresponding deflection of the balance rendered plainly visible. When the current was reversed the deflection was in the opposite direction. By breaking and closing the circuit at proper intervals to augment the oscillations, the large frame was readily made to oscillate through an arc of five degrees. When the sides of the rectangle were placed north-east and south-west the current produced no sensible effect. A bichromate-of-potash battery of 16 cells, with plates 25 by 6 centimetres surface was used. With a rectangle having a larger number of coils, attached to a very delicate balance, and a steady battery current, the variations in the magnetism of the earth might thus, Professor Broun thinks, be advantageously observed.

ELECTRO-MOTIVE FORCE OF GALLIUM.—According to former experiments of M. Jules Regnault, the different liquid amalgams have different electro-motive qualities, and he has attributed this fact to the different values of their specific heat. Recently, before the Academy of Sciences, Paris, he demonstrated this assumption by means of the metal gallium, which, as is well known, will after fusion remain liquid at ordinary temperature

He made a small pile out of a plate of solid gallium, covered with a sheet of paper impregnated with solution of sulphate of gallium, and overlaid by a drop of liquid gallium. The metals were joined up through a galvanometer, and on completing the circuit a current showed the liquid metal to be attacked, that is to say, the pole of the highest specific heat.

THE question of including Mauritius in the telegraphic system of the world was brought before the Chamber of Commerce of that island at its meeting on the 13th ult. The chamber was of opinion that a cable *via* the West Coast of Africa, as suggested by Mr. Donald Currie, would effectually destroy their hopes of telegraphic communication, and it was considered that the moment had arrived when the Chamber should once again endeavour to obtain from the home authorities that Mauritius should be included in any system of ocean telegraphic communication between the Cape and any other country that may be decided upon. The President stated that Mauritius was the only sugar producing country depending solely upon steam communication. The matter was eventually referred to a special committee on state telegraphs.

A TARGET which by means of electricity shows instantaneously upon another target set up at the firing station the exact spot where a bullet strikes, and thus does away with the necessity of employing a marker to signal the result of each shot, has been recently perfected, after years of labour, by a Swiss locksmith. The exact details of the target in its latest form are not yet published, but a description was given a short time ago in a Swiss paper, and also in an Austrian military periodical, of a target on the same principle, which was successfully tried last year. In this target the face is divided into a number of concentric rings, and each ring again is divided by two lines drawn right across the faces and crossing each other at right angles at the centre. In each of the subdivisions of the target at the firing station a small hole is pierced, and when a bullet strikes the distant target, a number at once appears in the hole in the corresponding subdivision of the target near the shooter; or, should the ball strike upon one of the lines dividing the face of the target, numbers are shown in both the adjacent subdivisions. In the trials made with the target the apparatus worked perfectly during the eight days for which thefir ing was kept up; the only accident which happened being that once the electric wire was cut by a bullet.

"*Un Drame au fond de la Mer*" has been revived at the Theatre Historique, Paris. This play is founded on the novel of Cortambert, and it may be remembered that it involves the sailing of a cable ship and the laying of the cable. It is interesting as being the first attempt to idealize such an enterprise, and we cannot but admire the hardihood of the novelist who has attempted to extract romance out of real cable ship. It is plain, however, on seeing the drama, as presented at the Historique, that the writer was never on board a cable ship in his life. Perhaps it is just as well, for then he might have felt all the romance of it oozing out of his finger tips, and we should have had no drama at all. The time of the cable-laying scene is, we think, happily chosen. It is laid in the dusk, after the sun has set, and the stars have begun to appear. The paying out operations are highly original. The chief electrician takes hold of the cable where it issues from the tank, a small trap door in the stage, and passes it rapidly hand over hand to the cable machine, which resembles nothing so much as a letter press, surmounted by a Watt's governor. The governor revolves rapidly, puffing all the time like a steam engine. More electricians seize the cable, and direct it over the ship's bulwarks into the sea, all working at express speed, and keeping time with the governor, while the captain, the officers of the ship, and the supernumeraries recline or stand by in picturesque groups about the deck. At last comes the catastrophe—the cable parts. There is great uproar and confusion, and rushing to and fro of the captain and his crew, the baffled electricians, and the picturesque supers; but it is all of no avail. The end is overboard and lost in the sea. What can be done? Nothing, except to go overboard after it, and fetch it up again. Accordingly, the chief electrician, a very hard-worked official, and doubtless underpaid withal, dons a diver's dress, and accompanied by his two principal assistants, goes down to the bottom of the sea in search of the missing cable. He finds there a wreck, and this submarine scene, representing his descent through coral grottoes to the floor of the ocean, and the hull of the sunken ship with its motionless corpses, is the one redeeming feature of the drama. Doubtless the spectators who have never seen actual cable operations, or a cable ship, were charmed; but we could not help feeling that, after all, a real cable machine at work paying out ocean main at six knots an hour is a much finer sight than a theatrical one.

INDUCTION MACHINE FOR NICKEL PLATING.—By a simple modification of Siemens' armature, M. Gaiffe obtains sensibly constant induction currents for electroplating. Instead of a cylindrical bobbin turning concentrically within cylindrical notches in the poles of the inductor, M. Gaiffe employs a bobbin of elliptical section turning in elliptical notches. The major axis of the ellipse of the notches is in plan parallel to the arms of the inductor. The major axis of the ellipse of the bobbin is a little shorter than the minor axis of the notches, so that the rotation may go on without friction. By trials a relation can be established between the diameters of the two ellipses such that the changing of polarity, instead of taking place during a brief interval at each half-revolution, is produced gradually during the duration of the half-revolution, and consequently gives rise to a sensibly constant current. M. Gaiffe

does not pretend that a machine of this kind is more economical than one with ring-bobbins, but he holds that it has the advantage of being fitted to receive, whatever its dimensions, helices of wires of all thicknesses, a condition difficult to realise with annular-bobbins; and, consequently, with a given speed of rotation, it may be regulated so as to give the electromotive force required for the work with the least internal resistance.

THE funeral of the late Professor Henry was attended by the president and the members of the United States Executive, Congress having adjourned for the day.

Patents.

2193. "Improvements in apparatus for producing induced current of electricity, such improved apparatus being especially applicable to transmitting signals, and calling the attention of persons using electrical telephones."—A. F. ST. GEORGE, June 1.

2202. "Telephones."—W. H. PREECE, June 1.

2281. "Improved means and apparatus for distributing and regulating electric currents, to work lamps, and other electric apparatus."—DR. C. W. SIEMENS, June 7.

2288. "Apparatus for refracting, reinforcing, and modulating sound."—A. C. ENGERT, June 7.

2385. "Electric telegraphs."—E. A. COWPER, June 15.

2396. "Telephones and apparatus employed in electric circuits."—T. A. EDISON, June 15.

2399. "Improvements in and appertaining to the obtaining of light by means of electricity and in apparatus therefor."—W. P. THOMPSON (communicated by E. Reynier), June 17.

2401. "Apparatus for producing electric light."—C. DUBOS, June 17.

2407. "Improvements in the manufacture of articles produced by the electro-deposition of metal, and in apparatus therefor."—W. R. LAKE (communicated by J. W. Sufts). Complete. June 17.

2456. "Telephony."—N. J. HADDAN (communicated by G. Black and A. M. Rosebrugh), June 20.

2457. "Telephones and telephonic call mechanism."—H. J. HADDAN (communicated by A. M. Rosebrugh), June 20.

2467. "Electro-magnetic clocks." — S. SHEPHERD, June 20.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

3726. "Duplex telegraphic printing apparatus."—GERRIT LÖLKES JANSMA VANDER DER PLOEG. Dated October 8, 1877. 8d. This consists of a dial manipulator, a relay, and an electro-magnetic type-printing receiver with a double type wheel against which the paper is pressed.

3743. "Magneto-electric machines."—JOHN HENRY JOHNSON (communicated by the Alliance Company). Dated October 9, 1877. 6d. This machine is specially designed for producing electric lights by alternating positive and negative currents. The currents are collected without the use of rubbers, and consequently without the attendant heating due to friction. The frame work of the machine is rectangular, but built in the plan of a St. Andrew's Cross; the inducing horse-shoe magnets, are arranged in sets of four on the plan of a St. Andrew's Cross, and space is left at the centre of the cross between the poles of the magnets for the rotating axle carrying the armature bobbins, to pass. These sets of magnets form, as it were, partitions across the rectangular frame, the armature axle passing through the centre of each. The bobbins are set round the periphery of a wheel carried by the axle. Each armature so built up of bobbins, rotates between two sets of induction magnets, or partitions. In the machine described, there are four sets of inducing partitions with three bobbin armatures between. The whole of the currents are conducted to one ring by wires, and are transmitted through a rod to one of the bearings, where they are collected and distributed by a leading wire to the electric lamp or other receiver.

3750. "Electro-magnet hydraulic engine."—W. R. LAKE (a communication from K. C. Atwood, New York). Dated October 9, 1877. 2d. This consists in a means of controlling the water supply of a hydraulic engine, so as to give a reciprocating motion to the piston. (*Not proceeded with.*)

3822. "Electric telephony and telegraphy."—D. D. REDMOND. Dated October 16, 1877. 2d. This consists in a telephone in which the receiver is a thermo-pile. The sound waves, by the heat of compression, generate electrical waves, which are received and reconverted into sound waves by an electro-magnetic receiver, or by a second thermo-pile after the manner of Peltier's cross. The face of the pile may be covered with substances increasing the amount of heat for given sound, or the sound wave may be amplified by dancing flames. (*Not proceeded with.*)

3839. "Distributing and increasing with atmospheric electricity currents proceeding from a single source of electricity for supplying several lighting centres."—PAUL JABLOCHKOFF. Dated October 17, 1877. 4d. This consists in a means of supplying a number of centres of illumination from a single source, and strengthening the currents by atmospheric electricity—one electrode of the alternating dynamo-machine is connected to one pole of the condensers of large surface, the other pole of the condensers being led to the electric candle or Kaolin wick—the other electrode of the machine being led to the other side of the wick. Various ways of connecting up these condensers in circuit are figured. They act as storages of the current, allowing it to be distributed in different directions. The patent also claims that they develop atmospheric electricity, and accumulate it so that it can be utilized along with the machine electricity, thus giving a more powerful light.

3854. "Expansion and contraction coupling for signal and telegraph wires."—G. PICKERSGILL. Dated October 18, 1877. 6d. This consists of a metal cylinder or tube, provided with one or more piston rods, on each of which, and within the cylinder, are mounted any required number of rings or discs of vulcanized rubber. The rods, after passing through the covers on each end of the cylinder, are attached to the wires, and this allows the wires to expand and contract while keeping the required lightness.

3861. "Railway brake and signalling apparatus."—H. E. NEWTON (communicated by F. E. Eames, Watertown, New York, U.S.) Dated October 18, 1877. 1s. This consists of a vacuum brake and alarm, which is sounded when the brakes are applied, and indicates that part of the train to which they are applied.

3906. "Apparatus for indicating defects in roofs, bridges, &c."—F. BARBER (communicated by J. Forbes, Dartmouth, Nova Scotia). Dated, Oct. 22, 1877. 2d. This consists in connecting an electric circuit to a structure so that excessive strain on any particular part shall close the circuit and announce the fact. (*Not proceeded with.*)

3981. "Electric magnets and magnetic motor engines."—M. H. SMITH. Dated, October 27, 1877. 6d.

This consists in forming electro-magnets of a coil of wire surrounding a soft iron core, and enclosed in a cylinder of soft iron, the whole being set on an iron base-plate. The motor is formed of a circle of such electro-magnets, which, by a suitable make and break arrangement, cause a disc armature, pivoted over them, to "wobble." The disc is tilted and continually attracted round by successive magnets. The wobbling motion is transmuted, by a crank and shaft, into rotary motion.

4036. "Electric apparatus for applying railway brakes."—H. A. DIBBIN. Dated, October 31, 1877. 6d. This consists of an electric means of releasing or actuating brakes at the driver's option, or by the breaking of a coupling, or by an adverse signal. A magneto-electric battery is placed on the locomotive, or tender, and derives its motion from the axle or the steam of the latter. The circuit of the battery can be closed by the engine driver at will. Wires are also led throughout the train, so that a circuit is closed between the locomotive and any van of the train. A sphere or mass of metal is so adjusted in each van with respect to gravity that when any disconnection of the circuit, or cessation of the current liberates the keepers of certain electro-magnets, the sphere falls by its own weight on a suitable lever arrangement which actuates or releases the brakes employed of whatever kind they may be. The fall of the weight also strikes an alarm bell to warn the guard. Provision is also made for an adverse signal on the line, actuating a contact arrangement on the locomotive, and rupturing the circuit, and by this means putting on the brakes, and arresting the train. Voltaic batteries may also be employed.

Proceedings of Societies.

PHYSICAL SOCIETY.—JUNE 22nd, 1878.

Prof. G. C. FOSTER, Vice-President, and afterwards Prof. W. G. ADAMS, President, in the Chair.

THE following candidate was elected a Member of the Society:—Mr. F. W. Grierson.

Prof. W. G. ADAMS exhibited a new form of Polariscope suitable for projecting on to a screen the figures formed by any crystal, and for measuring the angle between the optic axes. Parallel light from the electric lamp, after traversing a Nicol of about 2-inches aperture, is rendered divergent by a set of lenses. The crystal under examination is placed in a recess formed by removing a slice from the middle of a spherical lens, which is capable of motion in any direction about its centre, while any movement in the vertical plane passing through the axis of the instrument can be measured by a scale and Vernier, and if, by such a motion, the point on the screen representing the position of one axis when the two are in the vertical plane, be transferred to that indicating the position initially occupied by the other axis, we have at once a measure of the optic angle of the crystal, for the rotation of two plano-spherical lenses, forming an exact sphere, has no effect on the direction of the beams.

Mr. WALTER BAILY read a paper on the effect of starch, salicene, unannealed glass, &c., on polarized light. In his experiments light was passed through a Nicol's prism, then through a quarter undulation plate, and then through a body having an optical structure symmetrical round an axis in the direction of the ray, such as any of the above-named substances. The axes of the quarter undulation plate being taken as axes of reference, ρ being the angle between the plane of polarization and one of these axes, σ half the difference of retardation at a given point between the part of the light resolved in a plane through the axis of the body and the part resolved perpendicular to that plane, ϕ being the angle between an axis of the quarter undulation plate and the perpendicular on the axis of the body from the given point (which perpendicular is taken as the initial line in the equation to the ellipse defining the light at such point) and $R\ \theta$ being the co-ordinates of this ellipse, the writer finds the equation to the ellipse to be

$$1 + A \operatorname{Cos} 2\theta + B \operatorname{Sin} 2\theta = R^{-2} \left\{ 1 - (A^2 + B^2) \right\}$$

where $A = -\operatorname{Cos} 2\rho \operatorname{Cos} 2\phi$

and $B = \operatorname{Sin} 2\rho \operatorname{Sin} 2\sigma + \operatorname{Cos} 2\rho \operatorname{Cos} 2\sigma \operatorname{Sin} 2\phi$

From this equation, diagrams have been drawn to exhibit the condition of the light at every point for different positions of the polarizer. For the simple case of salicene, or starch, in which the difference of retardation is the same, or nearly so, for all distances from the axis of the body the diagram consists of a ring of ellipses of various eccentricities and inclinations, each ellipse showing the condition of the light along the radius on which it lies. For the general case, in which the difference of retardation is a function of the distance from the axis of the body, the diagram consists of two series of curves, one series being "isomorphal" curves, or curves along which the eccentricity of the ellipse is constant, and the other series being "isoclinal," or curves along which the inclination of the axis major of the ellipse to the perpendicular on the axis of the body is constant. The general equation to the isomorphal lines is $A^2 + B^2 =$ constant, and to the isoclinal lines $\frac{A}{B} =$ constant. These two series of curves completely define the form and position of the ellipse of polarization at every point, and render it easy to determine what appearances will be presented on passing the light through an analyzing prism in any given position. The results obtained were illustrated by some experiments.

Prof. W. C. UNWIN made a communication on the flow from orifices at different temperatures. A paper recently appeared in the *Franklin Journal of Science*, by Mr. Isherwood, giving results of experiments on this subject, and according to him, the volume discharged from a given orifice is increased by about 12 per cent. on raising the temperature from 60° F. to 212°. It is difficult to accept this result, because the friction is known to diminish the discharge by an amount much less than 12 per cent., and no other cause than decrease of friction can be assigned to account for Mr. Isherwood's results. In the author's experiments, the increase of discharge at 190° above that at 60° was only 4 per cent. with conoidal orifices, in the form of the vena contracta; with thin edged orifices, the variation of discharge was still less. He is disposed to think that the great increase of discharge in Mr. Isherwood's experiments was due to diminution of friction in a rather small pipe leading to the orifices, and would not occur with any other arrangement.

Mr. GORHAM then read a paper on "Complementary Colours." He stated that the three primaries are green, red, and blue, that yellow is a binary compound of green and red; and that yellow and blue when mixed, form white. He remarked that after looking at a green disc the eye evokes another colour, but the undulations must be arrested by a gray surface. This was proved by an experiment.

Mr. Gorham next showed how the grays can be formed by cancelling either reflected or transmitted rays of white light. The first of these cases is illustrated by white paper painted over with a wash of Indian ink, and the second by the well known Berlin tiles, in which light and shade are obtained by giving varying thickness to the ware. He showed that this last effect may be imitated by piling strips of paper to varying heights, and he has succeeded in photographing geometrical figures so formed. Lastly, the author explained a method of arresting and showing the complementaries more satisfactorily than he

considers has hitherto been done. Six thicknesses of white paper are gummed together and cut into a ring, a ring of the same size and shape being also cut from a disc of coloured paper, and the white ring is let in to fill its place. On observing such a disc by white transmitted light the complement is seen through the ring.

Prof. S. P. THOMPSON exhibited a series of magnetic figures, illustrating electro-dynamic relations. The lines of magnetic force around a wire, carrying a magnetic current, can be shown by passing a wire through a glass plate, strewing iron filings around, and tapping the plate gently. The filings may be fixed in their places, if the plate has previously been gummed and dried, by softening the gum with steam. Such a prepared plate may be used to project the figures of the magnetic curves in the lantern. Two parallel like currents attract, their curves forming a figure illustrative of the action; or they repel if travelling in opposite directions, the repulsion also being evident from the form of the curves. It was shown by a series of such lantern slides that a very large number of electro-dynamic relations can be illustrated by curves produced in this manner. Figures were thrown upon the screen illustrating the law of oblique currents, the attraction of a magnet into or its repulsion out of a circuit, the deflection of a magnetic needle by a current, and the mutual tendency of a current and magnetic pole to rotate. A very curious figure was produced by a current running through a magnet longitudinally. A transverse section of the lines of force at a pole gave neither the radial lines of the magnet, nor the circular lines of the current, but a series of spirals. It was argued that Faraday's conception of the lines of force tending to shorten themselves supplied the means of interpreting the physical effects indicated by the lines of force in the various figures.

The SECRETARY read a paper by Mr. C. H. Hinton on the co-ordination of space.

An adaptation of the telephone and microphone, for communicating vibrations to the phoneidoscope, by Mr. TYSLEY, was then shown. The metal disc carrying the soap film, is fixed just above the telephone plate, and, this being in circuit with a microphone and battery, any vibration imparted to the microphone at once sets the soap film in action, the characteristic figures being at once obtained.

Mr. A. HADDON exhibited a modified form of microphone, which he has arranged with a view to make the same instrument available for receiving sounds of any given intensity. Its main peculiarity consists in having a thin strip of elastic attached to the middle of the pointed graphite. By varying the tension of this elastic, the sensitiveness of the instrument can be accurately regulated.

The meeting of the Society was then adjourned until November.

THE METEOROLOGICAL SOCIETY.

THE closing meeting of this society for the present session was held on Wednesday, the 9th ult., at the Institution of Civil Engineers, 25, Great George Street, Westminster, Mr. C. Greaves, F.G.S., President, in the chair. J. C. Philips, Esq., J.P., and W. S. Rawson, Esq., were ballotted for, and duly elected Fellows of the Society. The following papers were then read:—

"The Climate of Lundy Island," by A. J. Crespe, B.A., F.M.S. Lundy Island from its geographical position might be expected to have a mild damp climate, with cool summers, and warm winters, and a small diurnal range of temperature, and so, no doubt, it has, although certain local circumstances in addition to its peculiar configuration make the climate remarkably inclement, windy, and unpleasant. The island runs nearly due north and south, having an extreme length of four miles, and a breadth of from 200 yards to 1,600 or 1,800; there is a nearly flat tableland, or "top" running due north and south, having an altitude of 450 feet, shelter there is none, every current of wind sweeps the whole tableland. From the edge of the tableland the ground slopes away to the sea; sometimes the descent of the sideland is extremely abrupt, at other spots, more gradual, while the sidelands are deeply cut by caves, precipices, small bays and glens. All around the island the water is deep a few hundred yards off, while the currents are formidable, and tremendous seas break upon the rocks almost every day in the year. The *one* drawback of the place is the wind, so furious and continuous are the blasts, first from one quarter then from another, for days, and even weeks. When gales occur—they generally do so at short intervals—the force of the wind becomes incredible: walls torn down, gates and doors wrenched out of their fastenings, and the few buildings which can be blown down are more or less injured. Fogs are remarkable for their frequency and density, and are nearly always drenching. The rainfall is nearly 50 ins. per annum. February and March are said to be the coldest months, and August the hottest; the mean temperature of the year is about 50° or 51°.

"On the Auroral or Magnetic Cirrus," by the Rev. S. Barber, F.M.S.

"Contributions to the Meteorology of Natal," by Dr. R. J. Mann, F.R.A.S. This paper is a discussion of the observations taken at the Maritzburgh (2095 ft. above sea level) during the six years, 1860-1865; from it we learn that the summer of Natal is a season of copious rain, and the winter a season of relative dryness, also that the former is a time of abundant and frequent cloud, and the latter a time of preponderant sunshine. The summer is consequently cooler in a material degree than it would otherwise be, on account of the frequent prevalence of cloud, and the abundance of the rainfall; and the winter has its temperature materially raised from the constant occurrence of clear skies and bright sunshine. The mean annual rainfall was 31·13 ins., of which amount nearly 28 ins. came down during the six summer months (October to March), and scarcely more than 2 ins. during the four midwinter months (May to August). Thunderstorms are of frequent occurrence, the average exceeding seven per month from October to March. The thermometer rarely rises above 85° in the shade even in the summer months, unless a hot wind is blowing, it then amounts to somewhere between 85° and 97°, according to the strength of the sirocco. The degree of humidity indicated by the dry and wet bulb thermometers, when a hot wind is blowing, varies from 25 to 52 degrees of moisture. The highest temperature recorded during the six years was 97·0°, the lowest 29°, and the mean 63·3°.

Note on "The Mean Relative Humidity at the Royal Observatory, Greenwich," by W. Ellis, F.R.A.S. In this paper the author gives the mean relative humidity in each month of the year at 9 a.m. and 9 p.m., and the mean of the twenty-four hourly values, derived from the photographic records of the dry and wet bulb-thermometers for the twenty years, 1849-1868. The 9 a.m. value is smaller than the mean in summer, and larger in winter, and the 9 p.m. value is larger than the mean throughout the year, but most in summer. The mean monthly values change little from April to August, and from October to February; and there is a great decrease between February and April, and a corresponding great increase between August and October. The mean for the year is 80·7.

"On a method of sometimes determining the amount of the Diurnal Variation of the Barometer on any particular day," by the Hon. R. Abercromby, F.M.S.

"On the relative Duration of Sunshine at the Royal Observatory, Greenwich, and at the Kew Observatory, during the year 1877," by G. M. Whipple, B.Sc., F.R.A.S. The author having instituted a comparison of the amount of sunshine recorded at these two Observatories, finds that the totals show that, for the whole year, the excess in the number of hours the sun shone at Kew over the number at

Greenwich amounted to 171. This difference is, no doubt, due to the direction of the wind, for Greenwich lying to the south-east of the chief part of London, and having also large manufacturing establishments on its northern side, is greatly shaded by cloud—probably in a great measure due to smoke when the wind blows from W.N.W. or N., while at Kew, which is situated to the west of London, and is remote from factories and shipping, enjoys a larger percentage of sunshine with these winds. With winds from the N.E., S., and S.W., Kew has but slight advantage over Greenwich. With E. and S.W. winds, the London smoke is driven over Kew, and its presence in reducing the transparency of the air is evident in the diminished amount of sun recorded—the quantities being only 81 and 65 per cent. of those registered at Greenwich.

"Account of the atmospheric disturbance which took place in lat. 21° N., and long., 25° W., on January 27-28, 1877," by J. H. Carden.

"Notes on some remarkable cloud formations accompanying sudden and frequent changes of temperature and wind," by Capt. W. Watson, F.M.S.

General Science Columns.

CONTINUOUS BRAKES.

PART III.

WESTINGHOUSE AUTOMATIC BRAKE.

THIS brake has, up to the present time, established itself more in favour with the several railway companies than any other of its competitors. It consists first, of a small engine fixed on the locomotive, and deriving its steam direct from the boiler, which works a direct acting pump to force air at pressure into a main reservoir placed underneath the foot-plate of the engine. A line of tubing extends from the main reservoir longitudinally throughout the whole length of the train, with a cock at each end of each carriage, the connections between the carriages being formed of india-rubber hose and metal couplings. Under each vehicle a branch from the main pipe leads through a triple valve to a small supplementary air reservoir, and also to two vertical cylinders provided with pistons fixed under the carriage, and on either side of it, midway between the wheels. To the bottom of each cylinder is hung, by a pair of links, two cast iron cams or quadrants. Each cylinder is provided with a piston, the rod of which passes out through its upper end, and to the top end of this there are attached two links of such form that they pass down the outside of the cylinder. Near their lower ends these links are connected with the cams or quadrants just mentioned, and at their extreme lower ends they are connected with the thrust rods of the cast-iron brake blocks. Thus, when the cylinder piston rises, it draws upwards with it the two links last mentioned, and in doing this the eccentric quadrants roll against each other, forcing the links apart, and, acting on the brake-rods, thrust the brake blocks against the wheels. By the reverse of this action the brakes are made to leave the wheels. The brakes on the engine are similar in principle to the carriage brakes, but the blocks are applied lower down on the wheels, and the arrangement of cylinders and links is somewhat different. Upon a train being made up, compressed air is allowed, by opening a three-way cock on the engine, to flow from the main reservoir and charge the whole of the main pipe, and all the carriage reservoirs, at an uniform pressure, by which action the brakes, which in their normal position are applied to the wheels, are released.

When in actual working it is desired to apply the brakes, the compressed air is allowed to escape from the main pipe into the atmosphere, through the three-way cock above referred to. The reduction of pressure, to a small extent, by this means operates upon a diaphragm in the triple valve under each carriage, instantly closing a port between the carriage reservoirs and the main reservoir, but permitting, at the same time, the air under pressure to pass from the reservoir to the brake cylinders in proportion as the pressure in the main is reduced, and thereby applying the brakes. By restoring pressure from the main reservoir to the main pipes, the triple valves are shifted, so as to charge again the carriage reservoirs, at the same time opening a discharge port in each triple valve by which the air can escape from the brake cylinders, and thus release the brakes. The act of breaking asunder the train at any part has the same effect as allowing the air to escape from the main pipe through the three-way cock on the engine, or through openings provided for the same purpose in the guards' vans or elsewhere. During the experiments undertaken by the royal commission, from whose report the above particulars are taken, the time occupied in applying the brake from the engine to the rear vehicle, was from one and a half to one and three-quarter seconds, whilst the time occupied in taking it off was from three to six seconds; and this brake throughout all the experiments gave the most rapid action, both in putting on and taking off, of any that were tested. The mean retarding force of the Westinghouse Automatic Brake has been shown to be over ten per cent. of the gross load of the train, and the distances within which the trains were brought to a stand, at different speeds, were as follows:—At thirty miles an hour, 282 feet; at forty-five miles an hour, 634 feet; and at sixty miles an hour, 1,128 feet. These results were obtained with the use of sand; without sand the distances were 300, 675, and 1,200 feet respectively. It is unnecessary here to enter into details regarding the numerous accidents which, according to the reports of the Government inspectors, have been avoided altogether, or greatly reduced in their effects by the use of the Westinghouse Automatic Brake, and the general opinion entertained of its efficiency is, perhaps, best expressed by the number of railway companies that have, up to the present time, either wholly or in part adopted it for general use on their lines.

SMITH'S VACUUM BRAKE.

This brake, next after the Westinghouse Automatic, has apparently been more extensively tried than any other of the continuous brakes. Its arrangement is as

follows:—On the side of the smoke-box of the locomotive there are fitted two steam ejectors for exhausting air, which under ordinary circumstances operate conjointly, but are capable of acting independently in case one should get out of order. Under each van and carriage throughout the train there is an india-rubber cylinder, stiffened with internal metal rings, and capable of collapsing and expanding lengthwise, and under the tender there are two such cylinders. These cylinders are in communication with the ejectors on the engine by means of a double line of pipes, connected at the tail of the train, and forming a complete circuit through it, with hose couplings between the carriages. On steam being admitted to the ejectors by the driver, the air is exhausted from the collapsing cylinders, and the moveable end of each being connected with the ordinary brake gear of each carriage, the brakes are at once applied. By opening an air-valve the cylinders refill, and the brakes are released. In addition to the above, there may also be applied in the front and rear guards' van another arrangement for applying the brakes in case of emergency. This consists of an air-exhauster in each van, nearly over one of the axles. On this axle a grooved friction-wheel is bolted and keyed, and in line with this another grooved friction-wheel is suspended from the carriage in such a way that it can be thrown into gear with the first wheel, or kept clear, at pleasure. By means of a belt passing up through the floor of the van, the second wheel, when set in motion, drives the wheel of a rotary pump-exhauster fixed in the van. Near the pump in the van is a lever held up by a notch in a standard, and when the pump is required to work the lever is pushed out of the notch by a cam lever, by which operation the second friction-wheel under the carriage is thrown into gear with the axle-wheel, and, if the train is in motion, the pump is set to work, and the air exhausted from the collapsing cylinders under the carriages. By means of a cord attached to the cam lever in the van, and running the whole length of the train and on to the engine, the driver, or any guard or passenger in the train, has the power of starting the exhauster. In addition to this there may also be a cord connected with the collapsing cylinders under the carriage, by which any movement in them may be made to sound gong bells in the guards' vans, and close to the driver on the engine. Also by the act of the driver exhausting the air from the collapsing cylinders, by means of the ejectors, the pump exhausters in the vans are started. The action of this brake is slower than that of the Westinghouse, and in the experiments undertaken for the Royal Commission it was found that the time occupied in applying it from the engine to the rear vehicle was from 4½ to 5 seconds, whilst to take it off required about 24½ seconds. The mean retarding force of Smith's Vacuum Brake was shown to be 7·47 per cent. of the gross load when sand was used, and only 5·72 per cent. without it. Under these circumstances it can be no matter of surprise to find that the power of the brake in bringing a train to a stand within a certain distance is considerably inferior to that of the Westinghouse Brake; with sand, the train running 30 miles an hour was brought up in 403 feet, at 45 miles, in 907 feet, and at 60 miles in 1,612 feet, whilst without sand the distances were 525, 1,181, and 2,100 feet respectively.

(To be continued.)

ALLOTROPIC METALS.—M. M. P. Schutzenberger in continuing his researches on the deposition of metals by electrolysis now finds that other metals, and notably lead, assume an allotropic form as well as copper. When the current from a Bunsen element is passed through a solution of 10 parts of caustic potash in 100 of water, with a plate of lead for the positive electrode and a plate of copper or well-polished gold for the negative, the two plates being parallel and at a distance of from 3 to 4 centimetres, a burnished bluish white metallic coating may be seen to form on the negative plate. If at this moment the plate be withdrawn from the bath and exposed to the air after having been washed in luke-warm water which has been boiled, the coating quickly disappears, allowing the yellow colour of the underlying metal to show itself. It seems as if the metal had evaporated, but it really forms itself into oxide of lead, which no longer conceals by a thin covering the colour of the copper or gold. During the electrolysis hydrogen is given off at the negative pole, so that the proportion of lead removed from the positive plate is greater than that which is deposited on the negative electrode. When the dose of dissolved lead ceases to be very feeble, the metal which deposits itself, instead of forming a polished coating, takes the appearance of a voluminous gray sponge bearded by feathery masses. This sponge well-washed with boiled water, and dried in a vacuum, leaves a lead powder which transforms itself in less than an hour, by contact with the air at ordinary temperatures, into yellow crystalline oxide, having the aspect of talc. When on the development of this sponge, which is extremely voluminous, the distance between the two electrodes is notably reduced, or when the bath becomes too highly charged with the dissolved metal, the deposit suddenly changes and takes the well known appearance of the "tree of Saturn" (brilliant plates).

Allotropic copper, reduced to powder under water and washed, always retains some acetate interposed as well as oxide. The purest specimens, dried in a vacuum, disengage when warmed in an inert gas at 450° C., from $\frac{5}{10}$ to $\frac{3}{10}$ per cent. of condensable vapours in great part formed of acetic acid; the residue loses by hydrogen about 1 per cent. of its weight of oxygen. It is therefore impossible to decide by a direct experiment, whether the allotropic copper does or does not contain occluded hydrogen or non-eliminable at 100° C. In every case the proportion of this hydrogen does not surpass $\frac{3}{100}$ per cent., and it is hard to attribute to that proportion a marked influence over the properties of the metal.

The following experiment solves the question in favour of an allotropic modification of copper. A fresh plate which only disengaged nitric protoxide mixed with nitrogen, under the influence of dilute nitric acid (10 parts acid to 100 of water), was heated for 24 hours to a temperature of 100° C., in water slightly acidulated with acetic acid in a sealed tube. After cooling no increase of pressure was proved, the copper treated by the dilute nitric acid furnished nitric bioxide mixed with 10 per cent. at most of protoxides.

With water alone, the transformation affected itself equally, but was more or less slow or incomplete. After 24 hours' heating to 100° C., the copper gave $\frac{3}{5}$ of bioxide and $\frac{1}{5}$ of protoxide; when heated to 150° C., after 24 hours, it gave $\frac{3}{4}$ bioxide and $\frac{1}{4}$ protoxide. It is probable that a state of equilibrium is set up for each condition between the two kinds of copper as in transformations in general.

Suboxide of copper treated cold, in a fine powder, by nitric acid (at 10 parts for 100) behaves like a mixture of copper and bioxide, $Cu^2O = Cu + CuO$. It dissolves from the copper nitrate without disengaging any gas, and remains a finely divided copper which is not attacked by dilute nitric acid at ordinary temperature, and offers in consequence properties directly the inverse of those of the copper produced by electrolysis of the acetate.

CORRUGATED INDIA RUBBER has been applied to the tread of railway carriage steps in America, with a view of preventing slipping of the feet, even in wet weather.

VEGETABLE IVORY, as it is called, by M. Turpin, its inventor, is formed by mixing calcined magnesia with a solution of caoutchouc, and compressing the mixture in a casting mould, properly heated. It is simply caoutchouc hardened by admixture with magnesia. It is beautifully white, like ivory, and can be carved, tinted, and polished like it. Should its insulating properties admit, it may be useful to makers of telegraph apparatus.

NIGHT SIGNALS.—Lieutenant Very, of the U.S.N., has devised a pistol for firing coloured stars to a height of 60 or 80 metres in the air. They are bright enough to be seen at 10 or 12 miles. The two colours, red and green, by their combinations, are made to indicate the numbers from 1 to 10, and hence to signal all the articles of maritime tactics.

THE TALKING MACHINE OF PROFESSOR FABER, OF VIENNA.—Faber worked at the source of articulate sounds, and built up an artificial organ of speech, whose parts, as nearly as possible, perform the same function as corresponding organs in our vocal apparatus. A vibrating ivory reed, of variable pitch, forms its vocal chords. There is an oral cavity, whose size and shape can be rapidly changed by depressing the keys on a key-board. A rubber tongue and lips make the consonants; a little windmill turning in its throat rolls the letter *r*, and a tube is attached to its nose when it speaks French. This is the anatomy of this really wonderful piece of mechanism.—*Nature*.

SAILING CARS, driven by the wind, are now in use on the railway tracks which run over the long level prairies of Kansas, and other Western American States An average speed of thirty miles an hour is obtained on some of these.

METEORITES.—An examination of the meteoric fragments which recently fell at Santa Caterina in Brazil shows that there are two distinct types of meteoric iron—one characterised by the presence of a notable quantity of millerite, or sulphate of nickel, mixed with pyrrhottin—whilst the other contains pyrrhottin only, The iron is in the form of a metallic breccia, cemented by the sulphate. The first type contains hardly any carbon, while the second contains a considerable proportion.

THE ETHER.—According to the hypotheses put forward by M. Favê, at the French Academy of Sciences, the molecules of ponderable matter are constantly executing short and rapid vibrations, which set up wave motions in the ether. The length of the ether waves is proportional to the period of the vibrations. They are all propagated uniformly at the same speed, whatever be their length. The ether waves infringing on bodies whose molecules vibrate in the same period intensify the vibrations of the latter. They cross each other in space, each particle of the ether moving in the direction of the resultant of the forces to which it is subjected. Thermal, luminous, or chemical effects are produced according to the length and amplitude of the wave, and the vibratory system of bodies on which they impinge.

Correspondence.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

WE have much pleasure in publishing the subjoined letter:—

To the Editor of THE TELEGRAPHIC JOURNAL.

Sir,—My attention has been drawn to a paragraph in the *Telegraphic Journal* of the 15th ult., which infers that undue delay has taken place in declaring the dividend (payable 24th inst.) for the quarter ended 31st March last. I beg to inform you that the delay is consequent upon the time needed to remit this company's receipts from Brazil, and for the maturing of the bills which are payable ninety days after sight in London. The receipts for messages to South America are also subject to some delay.

I am, Sir,

Yours truly,

THOMAS FULLER,

Managing Director.